H13525

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	H13525

LOCALITY

State(s):	Michigan
General Locality:	Vicinity of Whitefish Point
Sub-locality:	Little Lake to Crisp Point

2021

CHIEF OF PARTY
John R. Bean

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	**H13525**

INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State(s):	**Michigan**
General Locality:	**Vicinity of Whitefish Point**
Sub-Locality:	**Little Lake to Crisp Point**
Scale:	**5000**
Dates of Survey:	**07/30/2021 to 08/22/2021**
Instructions Dated:	**06/02/2021**
Project Number:	**OPR-Z394-KR-21**
Field Unit:	**Ocean Surveys**
Chief of Party:	**John R. Bean**
Soundings by:	**Multibeam Echo Sounder**
Imagery by:	**Multibeam Echo Sounder Backscatter Side Scan Sonar**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Low Water Datum IGLD-1985**

Remarks: ***Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/.***

Products created during office processing were generated in NAD83 UTM 16N, LWD. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

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Descriptive Report to Accompany Survey H13525

Project: OPR-Z394-KR-21

Locality: Vicinity of Whitefish Point

Sublocality: Little Lake to Crisp Point

Scale: 1:5000

July 2021 - August 2021

Ocean Surveys

Chief of Party: John R. Bean

A. Area Surveyed

This survey provides hydrographic data for Lake Superior waters in the vicinity of Whitefish Point. The general locations of the survey limits are presented in Table 1.

A.1 Survey Limits

Data were acquired within the following survey limits:

Northwest Limit	Southeast Limit
46° 54' 50.61" N 85° 28' 1.01" W	46° 42' 52.23" N 85° 15' 3.21" W

Table 1: Survey Limits

Survey limits were acquired in accordance with the requirements in the Project Instructions and the HSSD.

A.2 Survey Purpose

The following text is quoted from the Purpose and Location section of the Project Instructions:

The survey area is located in Whitefish Bay, near the Southeast corner of Lake Superior. The total survey area is estimated to be around 300 SNM. Vessels entering or leaving Lake Superior must pass through the Soo Locks, located due East of Whitefish Point, making this survey area a very highly trafficked location. The survey area has reports of charting discrepancies and migrating shoals and the source data dates back to 1958 and predate modern survey methods. The data from this project will identify dangers to navigation and address a data gap in the National Bathymetric Source (NBS).

The survey area was nominated as Shipwreck Coastal National Marine Sanctuary in 2017 and is known by the name "Shipwreck Coast". Whitefish Point remains one of the most dangerous shipping areas in the Great Lakes (1). Known as the graveyard of the Great Lakes (2), more vessels have been lost in the Whitefish Point area than any other part of Lake Superior. Commercial fishing is also very prevalent in this area and takes place year-round, except when ice conditions are prohibitive. Further development of this area may have navigational, cultural as well as commercial significance.

This survey will provide contemporary data to update National Ocean Service (NOS) nautical charting products and services, improving the safety of the maritime traffic and services available to the area by reducing the current risk that is present due to outdated bathymetry.

Sources:
1) Stonehouse, Frederick (1985, 1998). Lake Superior’s Shipwreck Coast, pp. 13 & 267, Avery Color Studios, Gwinn, Michigan, U.S.A. ISBN 0-932212-43-3
2) "Chapter 4: The Watery Boundary". United Divide: A Linear Portrait of the USA/Canada Border. The Center for Land Use Interpretation. Winter 2015.

A.3 Survey Quality

The entire survey is adequate to supersede previous data.

The HydrOffice "QC Tools" application was used to calculate data density in the finalized surface for Survey H13525 and confirmed that the survey meets the HSSD data density requirements.

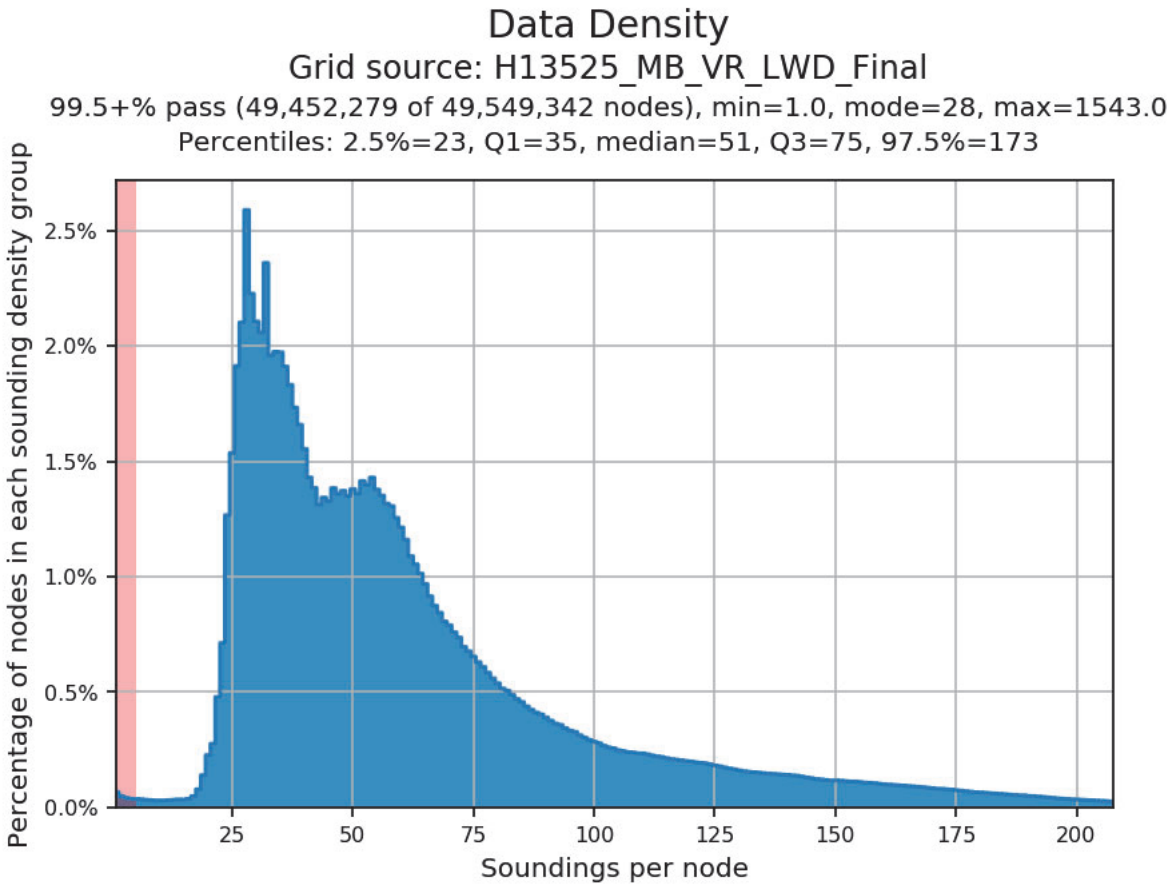


Figure 1: Survey H13525 grid data density.

A.4 Survey Coverage

The following table lists the coverage requirements for this survey as assigned in the project instructions:

Water Depth	Coverage Required
All waters in survey area	Complete Coverage (Refer to HSSD Section 5.2.2.3)
All waters in survey area	Complete a minimum of 4957 LNM. Transit mileage, system calibration mileage and data which do not meet HSSD specifications shall not count towards the completion of the LNM requirement. Notify the COR/Project Manager upon nearing completion of LNM requirement. The final survey area shall be squared off and ensure the full investigation of any features within the surveyed extent.

Table 2: Survey Coverage

Crosslines for Survey H13525 were run over the full extent of the sheet in order to understand the bathymetry and determine what portion of the sheet would be surveyed to meet the LNM requirement. Approximately 54% of the potential sheet area was surveyed to complete coverage, but the project LNM total was met without including the excess crossline mileage. All crossline data are included in the survey deliverables.

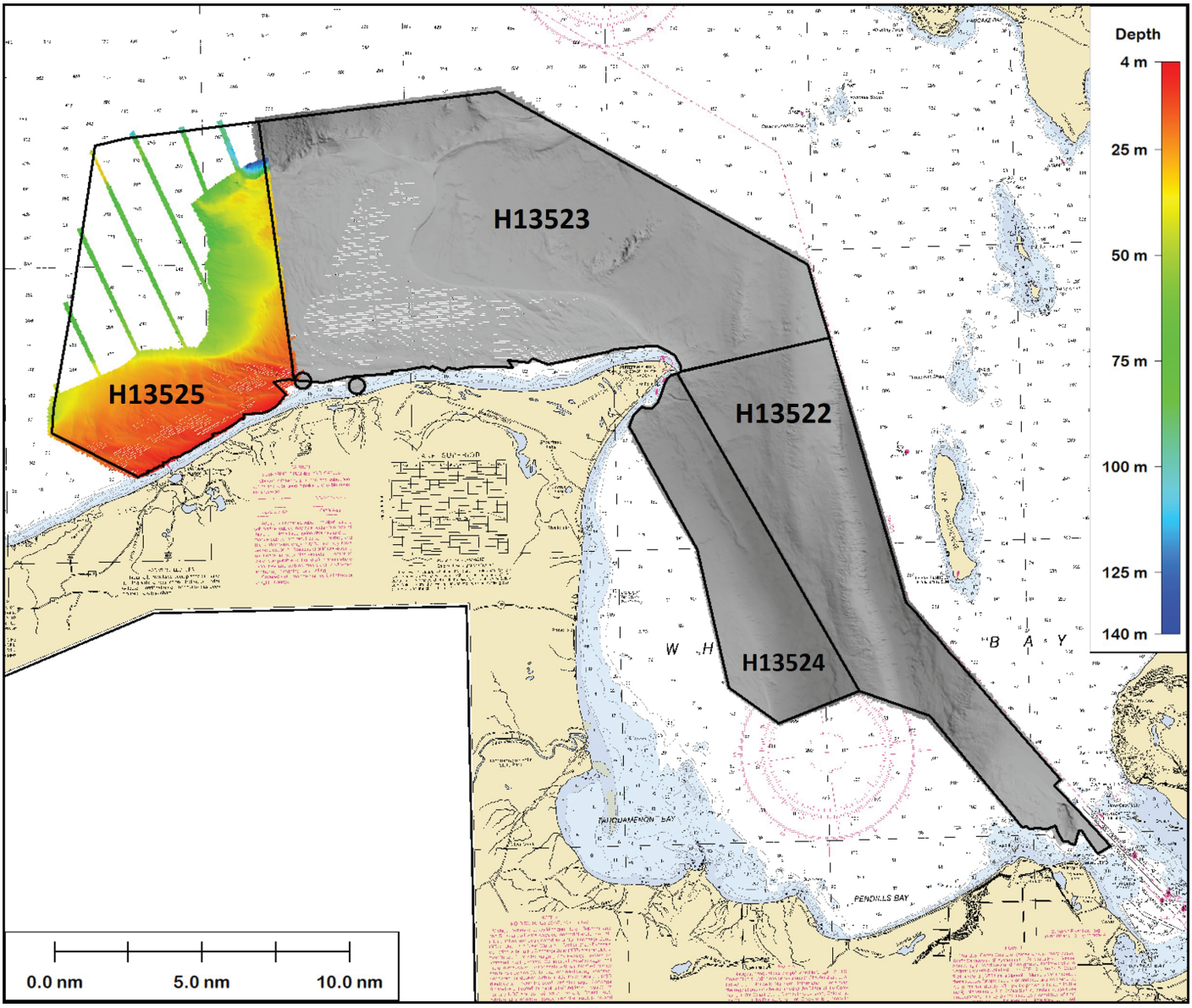


Figure 2: Survey H13525 MBES coverage.

A.6 Survey Statistics

The following table lists the mainscheme and crossline acquisition mileage for this survey:

	HULL ID	*MV Northstar Challenger*	*RV North Cove*	*RV H.F. Stout*	*Total*
LNM	**SBES Mainscheme**	0	0	0	0
	MBES Mainscheme	518.4	1.1	43.3	562.8
	Lidar Mainscheme	0	0	0	0
	SSS Mainscheme	0	0	0	0
	SBES/SSS Mainscheme	0	0	0	0
	MBES/SSS Mainscheme	177.8	70.6	0	248.4
	SBES/MBES Crosslines	52.4	2.0	0	54.4
	Lidar Crosslines	0	0	0	0
Number of Bottom Samples					0
Number Maritime Boundary Points Investigated					0
Number of DPs					0
Number of Items Investigated by Dive Ops					0
Total SNM					43.7

Table 3: Hydrographic Survey Statistics

The following table lists the specific dates of data acquisition for this survey:

Survey Dates	Day of the Year
07/30/2021	211

Survey Dates	Day of the Year
07/31/2021	212
08/01/2021	213
08/02/2021	214
08/04/2021	216
08/05/2021	217
08/18/2021	230
08/19/2021	231
08/20/2021	232
08/21/2021	233
08/22/2021	234

Table 4: Dates of Hydrography

B. Data Acquisition and Processing

B.1 Equipment and Vessels

Refer to the Data Acquisition and Processing Report (DAPR) for a complete description of data acquisition and processing systems, survey vessels, quality control procedures and data processing methods. Additional information to supplement sounding and survey data, and any deviations from the DAPR are discussed in the following sections.

B.1.1 Vessels

The following vessels were used for data acquisition during this survey:

Hull ID	*MV Northstar Challenger*	*RV North Cove*	*RV H.F. Stout*
LOA	28 meters	11.1 meters	9.1 meters
Draft	2.6 meters	0.8 meters	0.76 meters

Table 5: Vessels Used

Figure 3: MV Northstar Challenger configured for survey operations.

Figure 4: RV North Cove configured for survey operations.

Figure 5: RV H.F. Stout configured for survey operations.

B.1.2 Equipment

The following major systems were used for data acquisition during this survey:

Manufacturer	Model	Type
Teledyne RESON	SeaBat T50-R	MBES
Applanix	POS MV 320 v5	Positioning and Attitude System
Trimble	NetR9	Positioning System
AML Oceanographic	MVP30	Sound Speed System
AML Oceanographic	MVP30-350	Sound Speed System
AML Oceanographic	AML-3 LGR	Sound Speed System
AML Oceanographic	Micro SV-Xchange	Sound Speed System
EdgeTech	4200	SSS

Table 6: Major Systems Used

B.2 Quality Control

B.2.1 Crosslines

Crosslines for Survey H13525 were run for final coverage determination, and so extend beyond the completed mainscheme coverage. The percentage of total crossline to mainscheme data was 6.7%, but when considering only crosslines within mainscheme survey coverage the percentage of crossline to mainscheme data was 3.6%.

Agreement between crossline and mainscheme data was good, with a mean difference of 0.03 m. Greater differences were observed in outer beam data and in deeper water. A histogram of depth differences is shown below.

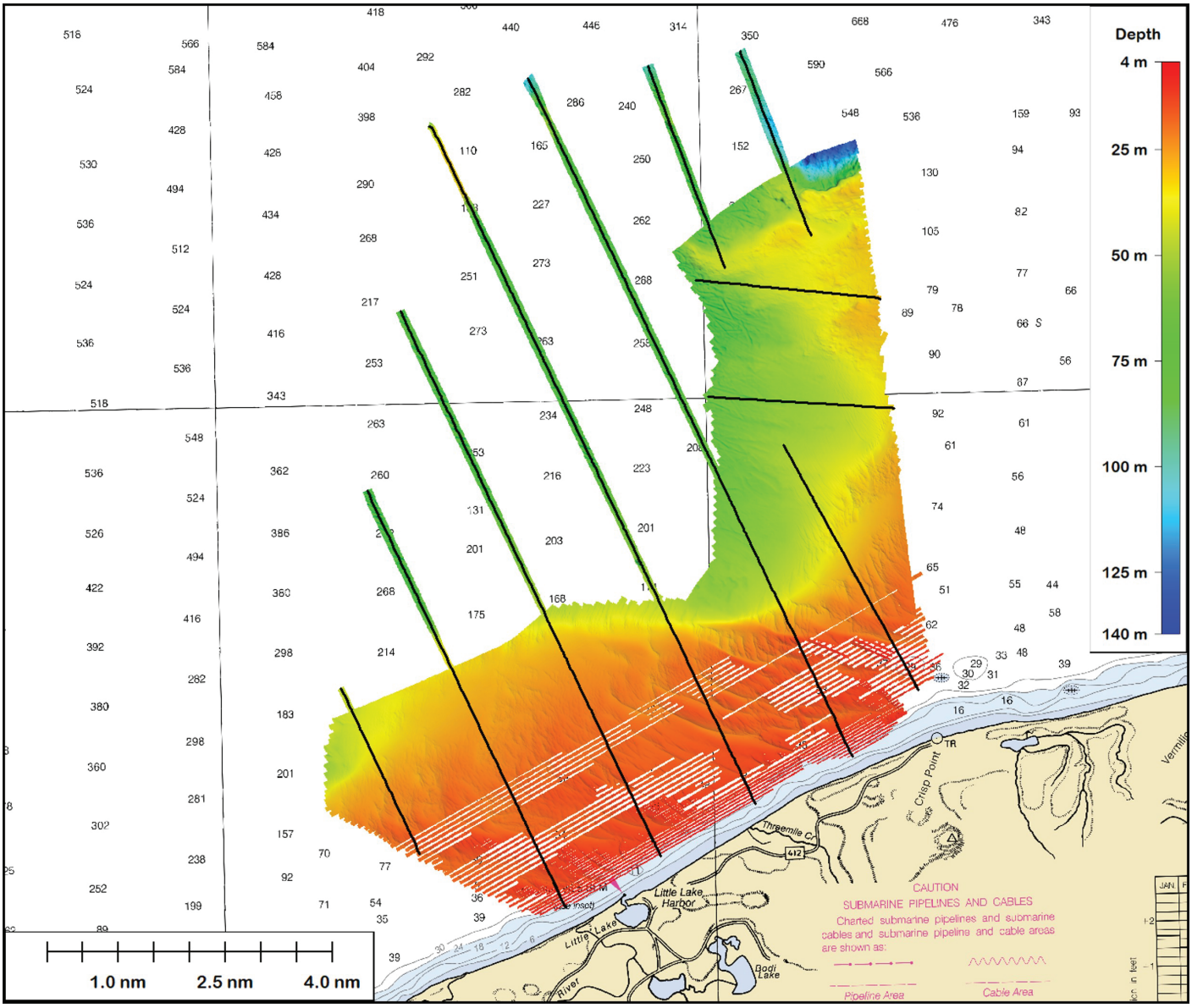
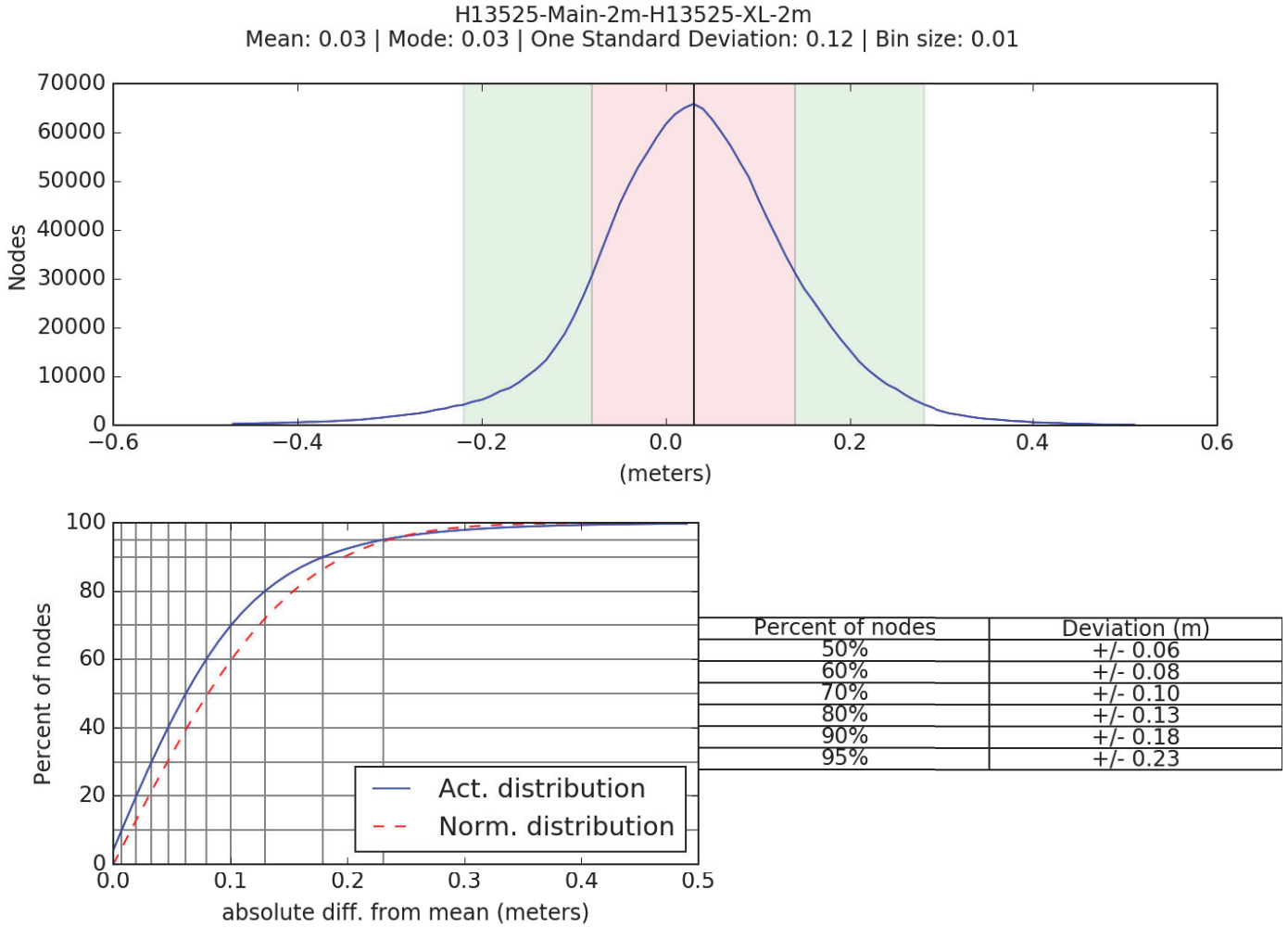


Figure 6: H13525 crossline tracks overlaid on a coverage surface.



Percent of nodes	Deviation (m)
50%	+/- 0.06
60%	+/- 0.08
70%	+/- 0.10
80%	+/- 0.13
90%	+/- 0.18
95%	+/- 0.23

Figure 7: Depth differences between H13525 mainscheme and crossline data.

B.2.2 Uncertainty

The following survey specific parameters were used for this survey:

Method	Measured	Zoning
ERS via VDATUM	0 meters	0.045 meters

Table 7: Survey Specific Tide TPU Values.

Hull ID	Measured - CTD	Measured - MVP	Surface
MV Northstar Challenger	N/A	4 meters/second	1 meters/second
RV North Cove	N/A	4 meters/second	1 meters/second
RV H.F. Stout	4 meters/second	N/A	1 meters/second

Table 8: Survey Specific Sound Speed TPU Values.

The HydrOffice "QC Tools" application was used to calculate TVU QC, determined by a ratio of uncertainty to the allowable error per NOAA and IHO specifications. A variable resolution surface was finalized in CARIS HIPS using the "greater of the two" option to select the greater value of either the uncertainty or standard deviation for the uncertainty source. The surface passed the uncertainty check, with 99.5+% of nodes meeting the uncertainty standards.

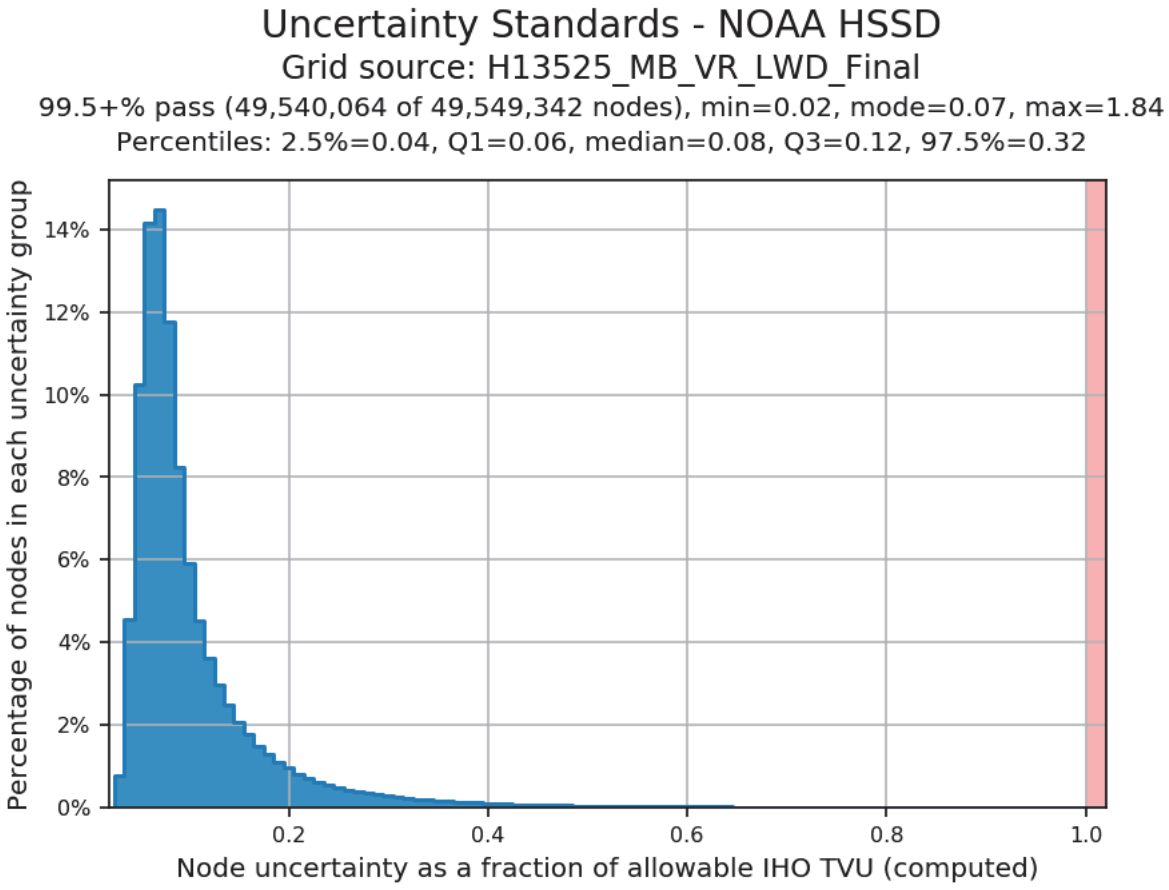


Figure 8: H13525 MBES surface uncertainty standards.

B.2.3 Junctions

Two surveys junction with Survey H13525: 1 prior survey and 1 contemporary survey. The prior survey is a shoreline topobathy lidar project collected as part of the USACE National Coastal Mapping Program (NCMP).

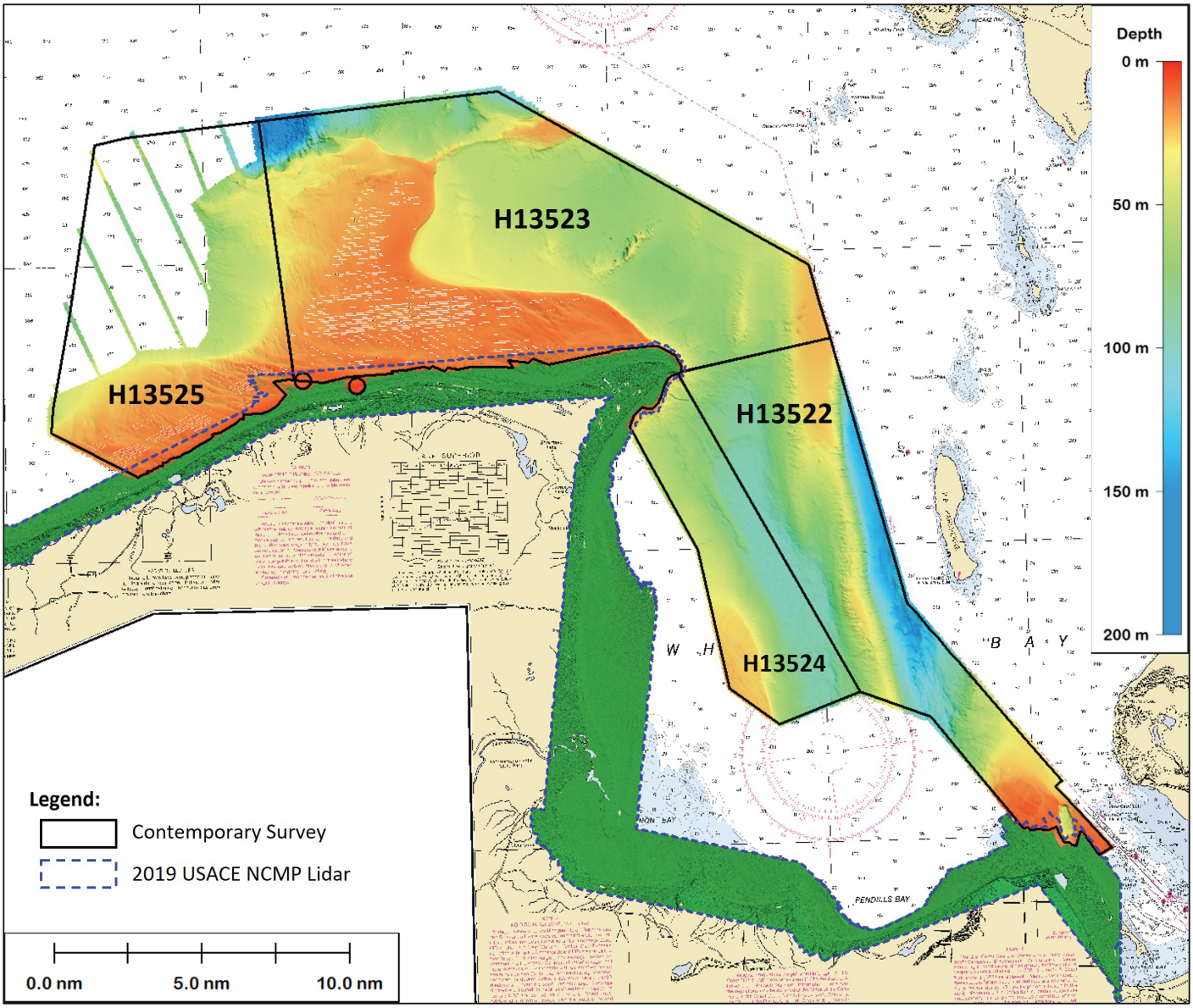


Figure 9: Survey junctions for Project OPR-Z394-KR-21.

The following junctions were made with this survey:

Registry Number	Scale	Year	Field Unit	Relative Location
2019 USACE NCMP	1:0	2019	JALBTCX Lidar	W
H13523	1:5000	2021	OSI	E

Table 9: Junctioning Surveys

2019 USACE NCMP

OSI received a preliminary digital elevation model of a recent topobathy lidar dataset from the USACE National Coastal Mapping Program that was undergoing review at Coast Survey at the time of the PI. The dataset has since been made publicly available, and the published data downloaded for the junction comparison.

The topobathy lidar data junctions with the southern end of Survey H13525 where the survey nears the shoreline. The junction area is approximately 2.5 SNM and shows a consistent bias of approximately 0.12 m, with H13525 survey data deeper than the topobathy lidar data. Greater discrepancies were observed near the center of the junction area, where undulations in the bathymetry suggest shifting sediment as the cause of the differences. Overall agreement was good, with 99% of nodes in the difference surface passing the allowable error fraction check.

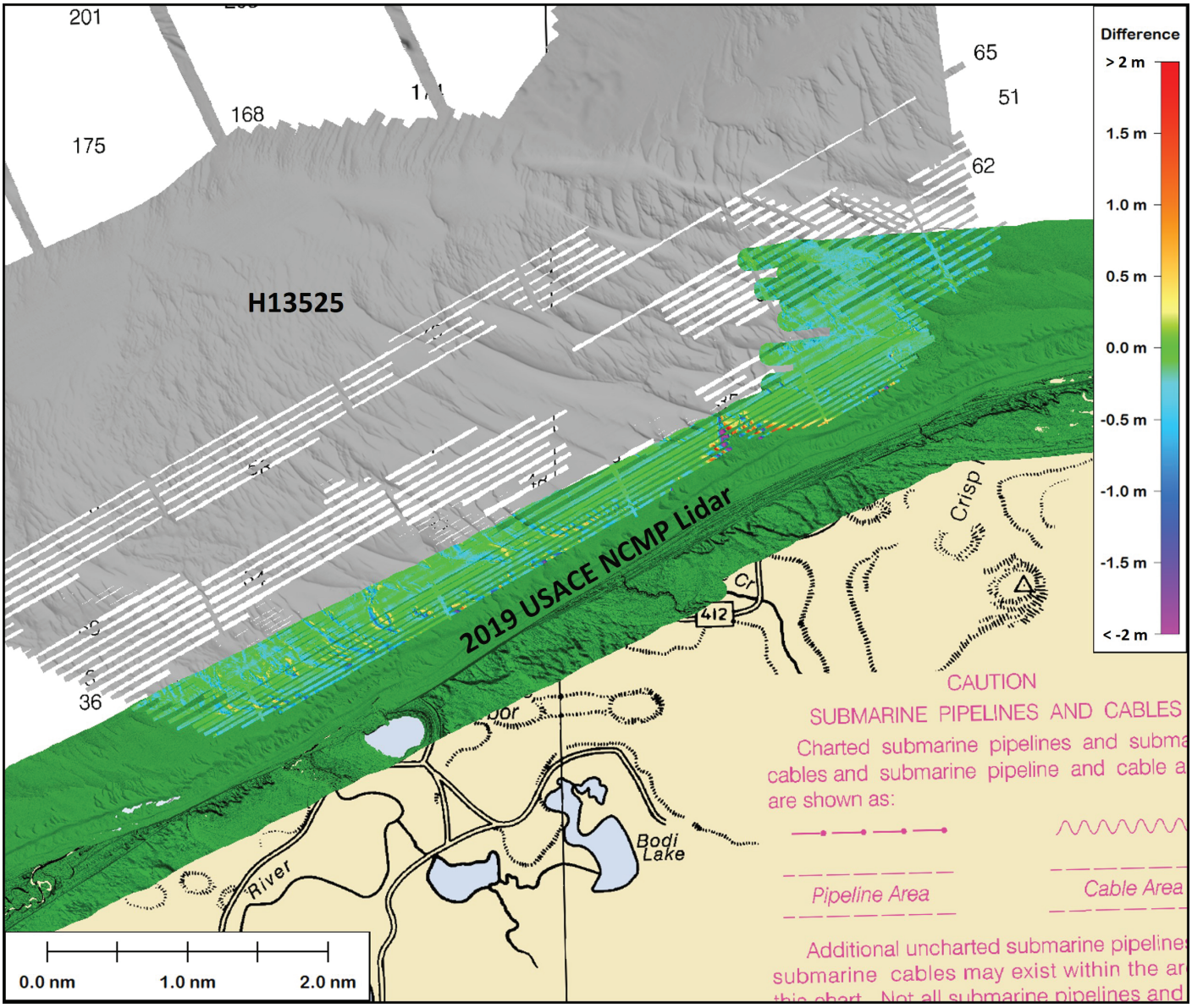
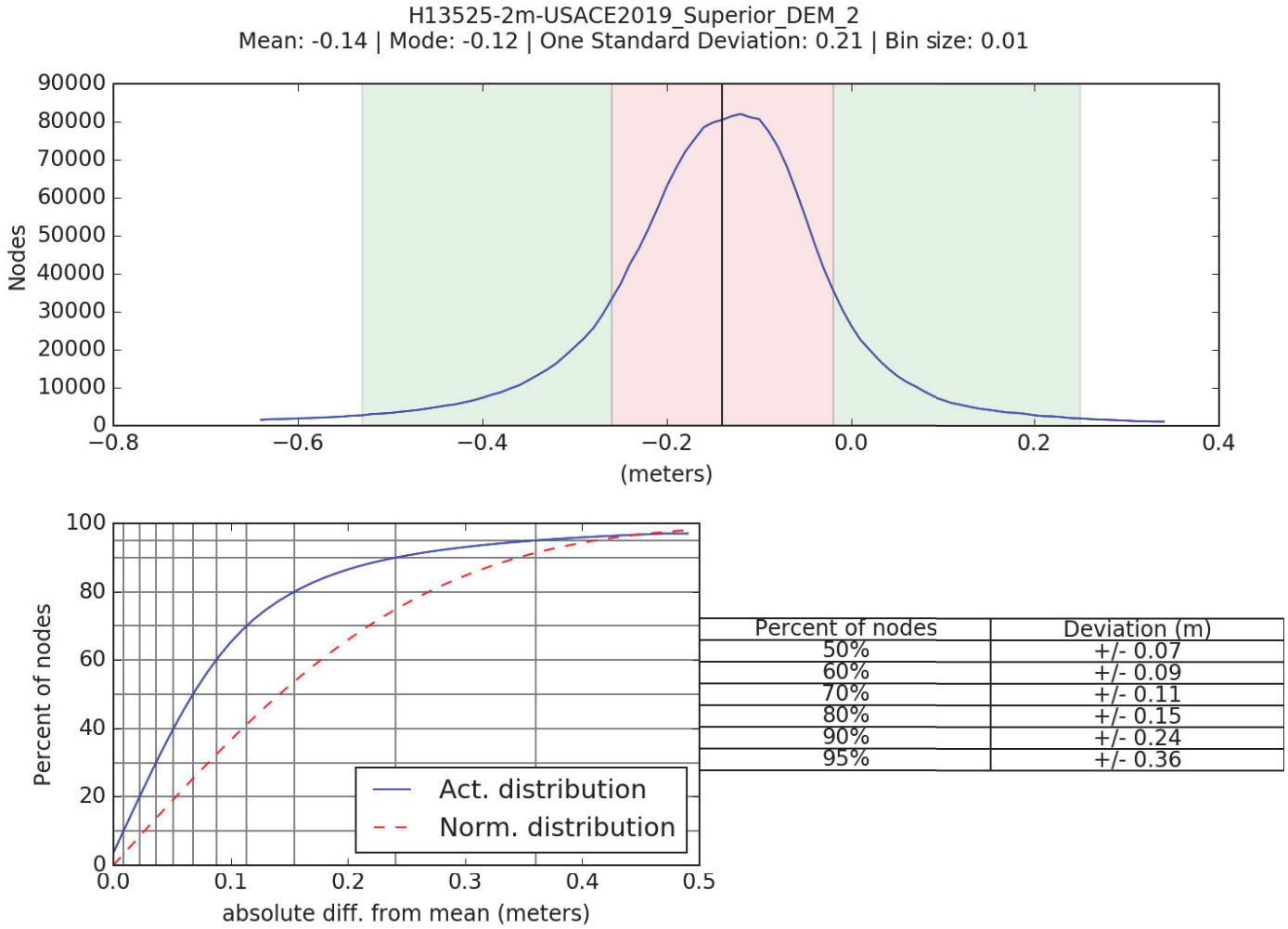


Figure 10: Survey H13525 to NCMP lidar junction area.



Percent of nodes	Deviation (m)
50%	+/- 0.07
60%	+/- 0.09
70%	+/- 0.11
80%	+/- 0.15
90%	+/- 0.24
95%	+/- 0.36

Figure 11: Depth differences between Survey H13525 and NCMP lidar.

H13523

The junction with contemporary survey H13523 is addressed in the DR for that survey.

B.2.4 Sonar QC Checks

Sonar system quality control checks were conducted as detailed in the quality control section of the DAPR.

B.2.5 Equipment Effectiveness

There were no conditions or deficiencies that affected equipment operational effectiveness.

B.2.6 Factors Affecting Soundings

Thermal Layering

Thermal stratification was observed throughout the survey area, causing sound speed variations that correlate to factors including the day, time, water depth, and bathymetric features such as slopes or sand waves. In data processing, sound speed profiles that did not adequately reflect the surrounding water mass were identified and removed, edited, or replaced. Sound speed casts were primarily applied using the CARIS HIPS "Nearest in Distance within Time" method, so removing a profile collected on a steep slope would allow deeper and shoaler casts on either side to be applied instead. Some shoal water casts that were applied along a downslope to deeper areas were edited by appending the lower portion of a cast from nearby deep water. Casts that were empirically found to represent a large water zone were added at additional locations within that zone to ensure proper corrections given the cast selection options available in the CARIS sound speed tools. Bathymetry, uncertainty, and standard deviation surfaces were used to direct editing and determine the accuracy of sound speed cast selection.

B.2.7 Sound Speed Methods

Sound Speed Cast Frequency: MVP casts were taken at intervals of approximately 20 minutes on the MV Northstar Challenger and approximately 30 minutes on the RV North Cove. AML-3 casts were taken approximately every hour on the RV H.F. Stout.

Hydrographers acquired more frequent sound speed profiles if high variability was noted in the surface sound speed from the AML Micro-X installed on the head of the transducer, or when the surface sound speed comparison threshold was exceeded (>2 m/s change) between the profile reading at the draft of the transducer and the Micro-X.

On some occasions, the RV North Cove and RV H.F. Stout were operating in close proximity, in which case the MVP30 casts from the RV North Cove were used for both vessels.

OSI submitted sound speed data in NetCDF format to the National Centers for Environmental Information (NCEI) on Dec 7, 2021 via the SN2 tool.

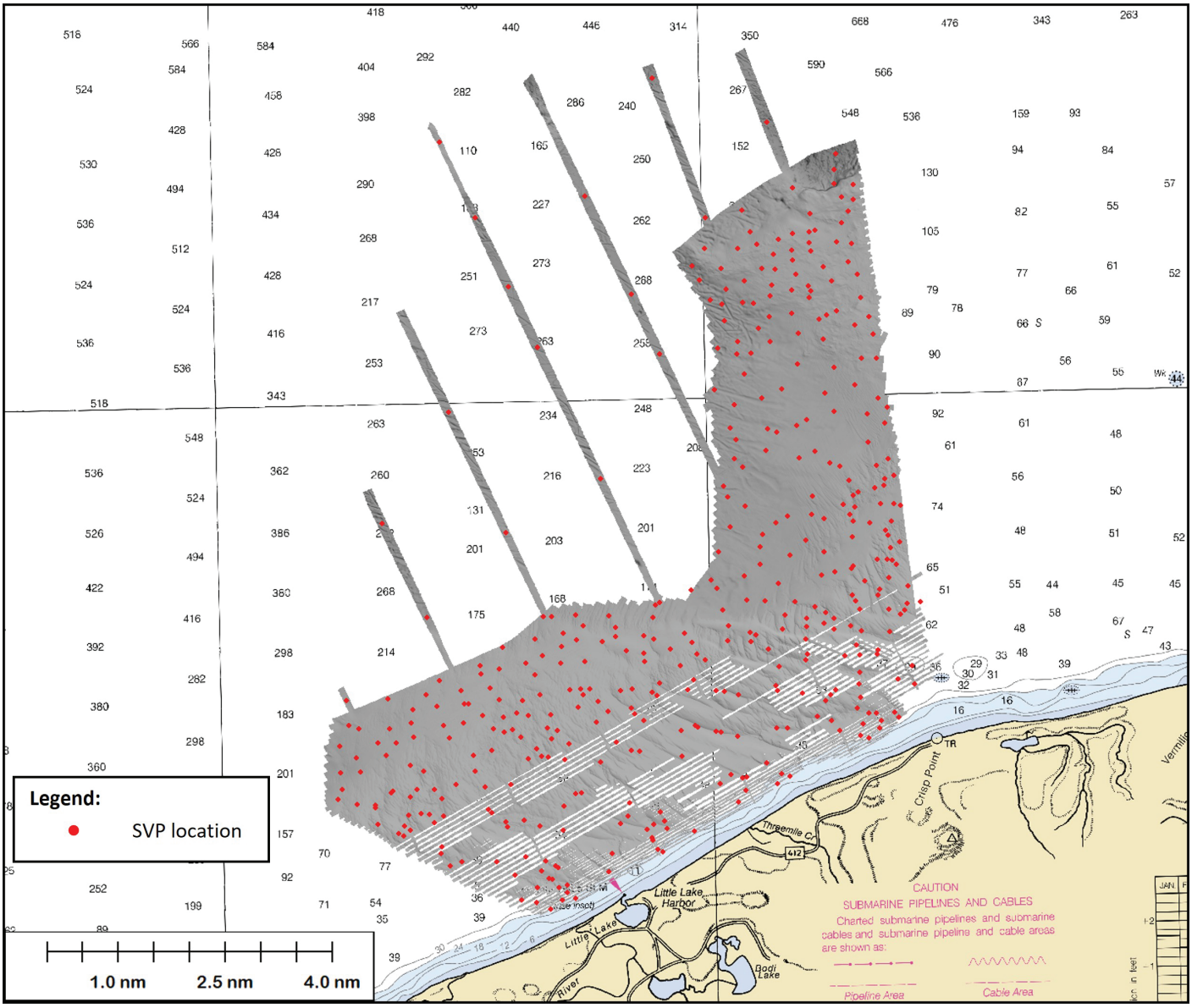


Figure 12: Locations of sound speed profiles measured in Survey H13525.

B.2.8 Coverage Equipment and Methods

The survey area has a wide range of depths and complex bathymetry. To efficiently achieve complete coverage, an adaptive TIN-based workflow was developed to create line plans with variable spacing. The tool was automated (with tweaks) and used charted data, crossline data, and mainscheme data as acquired to generate line plans as the survey progressed.

B.3 Echo Sounding Corrections

B.3.1 Corrections to Echo Soundings

All data reduction procedures conform to those detailed in the DAPR.

B.3.2 Calibrations

All sounding systems were calibrated as detailed in the DAPR.

B.4 Backscatter

All equipment and survey methods were used as detailed in the DAPR.

B.5 Data Processing

B.5.1 Primary Data Processing Software

The following Feature Object Catalog was used: NOAA Profile Version 2021.

B.5.2 Surfaces

The following surfaces and/or BAGs were submitted to the Processing Branch:

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H13525_MB_VR_LWD_Final.csar	CARIS VR Surface (CUBE)	Variable Resolution	4.204 meters - 139.331 meters	NOAA_VR	Complete MBES
H13525_MB_VR_LWD.csar	CARIS VR Surface (CUBE)	Variable Resolution	4.204 meters - 139.331 meters	NOAA_VR	Complete MBES

Surface Name	Surface Type	Resolution	Depth Range	Surface Parameter	Purpose
H13525_SSSAB_1m_600kHz_1of1.tiff	SSS Mosaic	1 meters	-	N/A	100% SSS

Table 10: Submitted Surfaces

C. Vertical and Horizontal Control

Additional information discussing the vertical or horizontal control for this survey can be found in the accompanying HVCR.

C.1 Vertical Control

The vertical datum for this project is Low Water Datum IGLD-1985.

ERS Datum Transformation

The following ellipsoid-to-chart vertical datum transformation was used:

Method	Ellipsoid to Chart Datum Separation File
ERS via VDATUM	OPR-Z394-KR-21_Whitefish_Bay_VDatumBuffer1282021_100m_NAD83_2011-LWD_IGLD85_Geoid18.csar

Table 11: ERS method and SEP file

A VDatum Separation Model (SEP) was provided by NOAA with the original project files and described in the PI. An updated SEP model to increase coverage area was requested and supplied during final data processing.

C.2 Horizontal Control

The horizontal datum for this project is North American Datum of 1983 (NAD 83).

The projection used for this project is Universal Transverse Mercator (UTM) Zone 16.

The following PPK methods were used for horizontal control:

- Smart Base

The following CORS Stations were used for horizontal control:

HVCR Site ID	Base Station ID
LITTLE CURRENT	LCUR
MICHIPICOTEN	MCHN
SAULT STE MARIE	MILS
MIMQ MARQUETTE	MIMQ
MUNISING	MIMU
MINB NEEBISH ISLAND	MINB
MANISTIQUE	MIQE
ST. IGNACE	MISI
POINT IROQUOIS	PTIR
ROSSPORT	ROSS
ESCANABA	SUP2
NEWBERRY	SUP3
ABRAMS	WIAB
CRANDON	WICR

Table 12: CORS Base Stations

The following user installed stations were used for horizontal control:

HVCR Site ID	Base Station ID
Ocean Surveys Whitefish Point	OSWP

Table 13: User Installed Base Stations

D. Results and Recommendations

D.1 Chart Comparison

D.1.1 Electronic Navigational Charts

The following are the largest scale ENCs, which cover the survey area:

ENC	Scale	Edition	Update Application Date	Issue Date
US4MI2QR	1:80000	1	11/10/2020	11/10/2020
US4MI2RR	1:80000	1	01/04/2021	01/04/2021

Table 14: Largest Scale ENCs

D.1.2 Shoal and Hazardous Features

No shoals or potentially hazardous features exist for this survey.

D.1.3 Charted Features

No charted features exist for this survey.

D.1.4 Uncharted Features

An uncharted wreck was surveyed and is associated with the publicly available coordinates of an identified wreck. No other features were observed in Survey H13525.

D.1.5 Channels

No channels exist for this survey. There are no designated anchorages, precautionary areas, safety fairways, traffic separation schemes, pilot boarding areas, or channel and range lines within the survey limits. Recommended tracks not based on a system of fixed marks were present but not investigated.

D.2 Additional Results

D.2.1 Aids to Navigation

No aids to navigation (ATONs) exist for this survey.

D.2.2 Maritime Boundary Points

No Maritime Boundary Points were assigned for this survey.

D.2.3 Bottom Samples

No bottom samples were required for this survey.

D.2.4 Overhead Features

No overhead features exist for this survey.

D.2.5 Submarine Features

No submarine features exist for this survey.

D.2.6 Platforms

No platforms exist for this survey.

D.2.7 Ferry Routes and Terminals

No ferry routes or terminals exist for this survey.

D.2.8 Abnormal Seafloor or Environmental Conditions

No abnormal seafloor or environmental conditions exist for this survey.

D.2.9 Construction and Dredging

No present or planned construction or dredging exist within the survey limits.

D.2.10 New Survey Recommendations

No new surveys or further investigations are recommended for this area.

D.2.11 ENC Scale Recommendations

No new ENC scales are recommended for this area.

E. Approval Sheet

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

All field sheets, this Descriptive Report, and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch.

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys Specifications and Deliverables, Field Procedures Manual, and Letter Instructions. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

Approver Name	Approver Title	Approval Date	Signature
John R. Bean	Chief of Party	12/16/2021	John R. Bean 2021.12.16 14:50:52 -05'00'
David T. Somers	Data Processing Manager	12/16/2021	David T. Somers 2021.12.16 14:51:18 -05'00'

F. Table of Acronyms

Acronym	Definition
AHB	Atlantic Hydrographic Branch
AST	Assistant Survey Technician
ATON	Aid to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BAG	Bathymetric Attributed Grid
BASE	Bathymetry Associated with Statistical Error
CO	Commanding Officer
CO-OPS	Center for Operational Products and Services
CORS	Continuously Operating Reference Station
CTD	Conductivity Temperature Depth
CEF	Chart Evaluation File
CSF	Composite Source File
CST	Chief Survey Technician
CUBE	Combined Uncertainty and Bathymetry Estimator
DAPR	Data Acquisition and Processing Report
DGPS	Differential Global Positioning System
DP	Detached Position
DR	Descriptive Report
DTON	Danger to Navigation
ENC	Electronic Navigational Chart
ERS	Ellipsoidal Referenced Survey
ERTDM	Ellipsoidally Referenced Tidal Datum Model
ERZT	Ellipsoidally Referenced Zoned Tides
FFF	Final Feature File
FOO	Field Operations Officer
FPM	Field Procedures Manual
GAMS	GPS Azimuth Measurement Subsystem
GC	Geographic Cell
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
HSD	Hydrographic Surveys Division

Acronym	Definition
HSSD	Hydrographic Survey Specifications and Deliverables
HSTB	Hydrographic Systems Technology Branch
HSX	Hypack Hysweep File Format
HTD	Hydrographic Surveys Technical Directive
HVCR	Horizontal and Vertical Control Report
HVF	HIPS Vessel File
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
ITRF	International Terrestrial Reference Frame
LNM	Linear Nautical Miles
MBAB	Multibeam Echosounder Acoustic Backscatter
MCD	Marine Chart Division
MHW	Mean High Water
MLLW	Mean Lower Low Water
NAD 83	North American Datum of 1983
NALL	Navigable Area Limit Line
NTM	Notice to Mariners
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRT	Navigation Response Team
NSD	Navigation Services Division
OCS	Office of Coast Survey
OMAO	Office of Marine and Aviation Operations (NOAA)
OPS	Operations Branch
MBES	Multibeam Echosounder
NWLON	National Water Level Observation Network
PDBS	Phase Differencing Bathymetric Sonar
PHB	Pacific Hydrographic Branch
POS/MV	Position and Orientation System for Marine Vessels
PPK	Post Processed Kinematic
PPP	Precise Point Positioning
PPS	Pulse per second

Acronym	Definition
PRF	Project Reference File
PS	Physical Scientist
RNC	Raster Navigational Chart
RTK	Real Time Kinematic
RTX	Real Time Extended
SBES	Singlebeam Echosounder
SBET	Smooth Best Estimate and Trajectory
SNM	Square Nautical Miles
SSS	Side Scan Sonar
SSSAB	Side Scan Sonar Acoustic Backscatter
ST	Survey Technician
SVP	Sound Velocity Profiler
TCARI	Tidal Constituent And Residual Interpolation
TPU	Total Propagated Uncertainty
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UTM	Universal Transverse Mercator
XO	Executive Officer
ZDF	Zone Definition File